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Vibro-Wind Energy Scavenging: An Example of Nonlinear Engineering

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In this paper we outline the principles of 'vibro-wind energy scavenging' using concepts of nonlinear dynamics of fluid-structure interactions. This application is an example of nonlinear engineering in which an unstable vibration is used to extract energy from the wind. Both experimental and computational results are presented for blunt-body aero-elastic nonlinear oscillators. The experimental results demonstrate that energy in both steady and unsteady air flows can be extracted and converted into stored electrical energy. Both the shape of the blunt body and the composite piezoelectric structure are optimized to become unstable in wind speeds as low as 2-3 meters per second while minimizing hysteresis. Several modes of fluid-structural excitation are explored including single mode galloping and vortex resonance phenomena. Three vibro-wind prototypes are described with arrays of 4 to 28 oscillators. Estimates of the potential for vibro-wind energy for architectural applications show that it could rival that of solar panels with power densities of from 10-50 watts per square meter.